The Integrative Design Process:
Reframing and Evolving the Practice of Green Building

F48
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Learning Objectives

- Identify and apply the concepts behind integrative design
- Recognize the benefits of an integrative process and whole systems thinking.
- Review and evaluate case study examples of projects that grew out of integrative design strategies.
Speakers

- John A. Boecker, AIA, LEED AP
- William G. Reed, AIA, LEED AP
What is Integrative Design?

... the key to cost effective and ecologically effective projects
What is Integrative Design?

... the intelligent integration of technology with nature

... but for what purpose?
Environmental Imperatives

What are the primary environmental imperatives we currently face?

- Climate Change
- Potable Water
- Resource Destruction
- Habitat Health
- Pollution/Toxins
What is Integrative Design? ... begin with definitions

Integrate:

to make into a whole by bringing all parts together; unify

Whole:

containing all components;
complete; not injured

Heal:

to make whole

Are we healing?
Are we wholing?
Natural Systems as Our Model for Interrelationships

From Permaculture Designers Manual, Bill Mollison
Natural Systems as Our Model
Environmental Imperatives . . . One System

- Potable Water
- Climate Change
- Resource Destruction
- Habitat Health
- Pollution/Toxins
Integrative Design: Building as an Organism

Systems Integration:

- Understanding relationships between systems
- Not a set of component parts
- Holistic, non-linear process
- Downsize or eliminate systems
- Analysis Tools
  - Energy modeling
  - Daylighting modeling
  - Materials analysis and impacts
Case Study Example: HVAC System Sizing

Combining systems impacts to reduce cooling capacity

Air Conditioning \( \text{ft}^2/\text{ton} \)

- Standard office building: 250 - 400
- PA DEP Spec: 600
- PA DEP Cambria Case Study: 663
Case Study Example:  Systems Impacts on Other Systems

**How does your interior paint color affect HVAC system costs?**

**Connections:**
- Paint
- Lighting
- HVAC Sizing for cooling

### Coefficients of Utilization PRU-9-A-04-2T8-SC-YMW-S-120

Floor effective floor cavity reflectance = .20

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The number of light fixtures can be calculated as:

\[
\text{# of light fixtures} = \frac{\text{footcandles} \times \text{area}}{\text{lumens} \times \text{LLF} \times \text{CU}}
\]

= 25% Reduction
Case Study Example: Team Process

Encourage each team member to think outside their discipline

Relocation of Mechanical Room:

- Original Design for mechanical room – Penthouse
- Optimized Design

Net First Cost Impact = $40,000 Reduction
Integrative Design Process Overview

Whole System Integrative Process (WSIP)

- Discovery
- Concept Design
- Schematic Design
- Design Development
- Construction Documents/Delivery

Front End
- (CoVO) - Continuous Value Optimization

Back End

Traditional Process

- Concept Design
- Schematic Design
- Design Development
- Construction Documents/Delivery

- VE - Value Engineering

Diagram Graphics by Doug Pierce
Integrative Design Process Overview
The Basic Elements of Integrative Design

• Fully engage Client in the design process
• Assemble the right team
• Facilitate co-learning

Part A: Discovery
• Align team around Purpose, Aspirations, Process
• Identify key systems / patterns of interrelationships
• Commit to specific measurable goals
• Map the Integration Process

Part B: Design & Construction
• Iterate for synergy – workshops / research & analysis
• Conceptualize system designs – before Schematic Design begins
• Optimize components as interrelated systems
• Document system stories – BOD, OPR . . . Commissioning
• Partner with Builders

Part C: Occupancy & Operations
• Maintain, Monitor, and Measure systems performance - FOREVER
• Respond to feedback - adjust key aspects of systems
Pre-Design – The Discovery Phase
Part A - The Discovery Phase

Part A and Part B Proposals

• Possible Part A and Part B proposals
• Part A Proposal: Initial Goal-Setting Workshop only
• Part B Proposal: After the Goal-Setting Workshop
  - Select the right team members based upon expertise needed
  - Define scope, program, and sustainability objectives
  - Scope and fees from all team members
Stage A.1- Research and Analysis:

“Preparation”

Avoids a “fact-free” meeting

- Preliminary Research to Prepare for the Goal-Setting Workshop (Workshop #1)
  - Site Selection - Assess optional sites
  - Context - Identify base ecological conditions: climate, habitat, history, etc.
  - Perform preliminary analysis of flows: four key sub-systems
  - Identify key stakeholders: People and non-human systems
  - Develop initial functional programmatic requirements
Four Key Sub-Systems

- **Habitat:**
  - Human, earth, and biotic systems

- **Water:**
  - Water quality and conservation, hydrology, soils

- **Energy:**
  - Energy efficiency and sources, microclimates, building use

- **Materials:**
  - Local material sources and waste opportunities
Integrative Design Team

The Composite Master Builder – Key stakeholders

- Owner
- Community Members
- Facilities Management Staff
- Planning Staff
- Facilities O&M Staff
- MEP Subcontractors
- General Contractor
- Construction Manager
- Product Manufacturers
- Cost Estimator
- Commissioning Authority
- Daylighting & Energy Modeler
- Landscape Architect
- Civil Engineer
- Electrical Engineer
- Mechanical Engineer
- Structural Engineer
- Architect
- Building Users

Adapted from graphic by Bill Reed
Stage A.2 - Workshop #1:
“Alignment of Purpose and Goal-Setting”

- Educate Participants about environmental issues and relationships
- Elicit Client’s Core Purpose for the project
- Touchstones: Values & Aspirations exercise
- Clarify functional and programmatic goals
- Establish initial performance targets and metrics – four key sub-systems:
  - Generate potential strategies and LEED goals
  - Determine order of magnitude cost impacts
- Provide time for reflection and feedback loops from Client and team
- Develop Process Roadmap identifying responsibilities, deliverables, dates
  - Part B Proposal
Touchstones: Values and Aspirations

A successful project would address what key issues?

- Climate Change
- Potable Water
- Resource Destruction
- Habitat Health
- Pollution/Toxins
# Touchstones Exercise Example

<table>
<thead>
<tr>
<th>Design Elements/Issues</th>
<th># of votes</th>
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</thead>
<tbody>
<tr>
<td>1. Energy and Resource Efficiency</td>
<td>56</td>
</tr>
<tr>
<td>2. Model of Restorative Approach Across Triple Bottom Line</td>
<td>52</td>
</tr>
<tr>
<td>3. Within Budget</td>
<td>44</td>
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<tr>
<td>4. Achieve LEED Platinum Certification</td>
<td>43</td>
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<tr>
<td>5. Maximize Indoor Air Quality</td>
<td>42</td>
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<td>6. Beautiful Landmark</td>
<td>40</td>
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<tr>
<td>7. Increased Green Space</td>
<td>40</td>
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<tr>
<td>8. Establish Connections as Catalyst for Neighborhood Transition</td>
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<tr>
<td>9. Pedestrian Friendly</td>
<td>37</td>
</tr>
<tr>
<td>10. Inclusive of Neighborhood in Design/Participation/Partnership</td>
<td>35</td>
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<tr>
<td>11. Building as Teaching Tool for Sustainability</td>
<td>28</td>
</tr>
<tr>
<td>12. Inspires Responsible Growth</td>
<td>24</td>
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<tr>
<td>13. Visually Aesthetic Streetscape</td>
<td>21</td>
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<tr>
<td>14. Renewable Energy Generation</td>
<td>17</td>
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<tr>
<td>15. Natural Systems Utilization</td>
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<tr>
<td>16. Hope for the Future/Neighborhood Opportunities</td>
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<tr>
<td>17. Area as Art and Cultural Destination</td>
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<tr>
<td>18. Eliminate Stormwater Runoff</td>
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<tr>
<td>19. Future Adaptability/Flexibility</td>
<td>9</td>
</tr>
<tr>
<td>20. Improvement of Creek</td>
<td>9</td>
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</tbody>
</table>
Stage A.3 - Research & Analysis

“Evaluating Possible Strategies”

- Explore and identify a wide range of opportunities and possible strategies before collapsing into solutions
- Expand analysis of four key sub-systems
- Evaluate design concepts against performance/LEED targets / test metrics
- Cx: Prepare conceptual phase OPR
- Apply unit costs to integrative cost bundling template
- Update Integration Process Roadmap
- Re-visit project scope and fees - Part B Proposal

Sub-System Analysis Example

Simple Box Energy Modeling:
- test configuration options (simple shapes and # of floors)
- test window options
- test solar shading strategies
- test other envelope load reductions
- test initial internal load options
Simple Box Energy Modeling
Load distributions & initial comparisons

Energy 10 simulations
Integrative Design Process Examples

Big Savings

cost less than

Small Savings

Less first cost is needed to save 40% energy than to save 20% energy.
Case Study Example:
Neptune Township Community School

NJ Elementary School & Community Center - 145,600 GSF
Energy Efficiency Measures (EEMs)

13 EEMs analyzed:

- solar orientation
- R27 wall w/ blown cellulose
- R30 roof insulation
- triple pane windows
- LPD = 0.92 W/sf
- solar shading
- light shelves
- daylight dimming
- ground source heat pumps
- underfloor supply air
- demand controlled ventilation
- energy recovery units
## Energy Modeling Parametric Runs – Individual EEMs

<table>
<thead>
<tr>
<th>ASHRAE Budget Building</th>
<th>Daylighting (1W/sqft)</th>
<th>Wood Frame Triple Pane</th>
<th>R27 Metal Frame Walls</th>
<th>R30 Roof Insulation</th>
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<tbody>
<tr>
<td><strong>Electric</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$124,184</td>
<td>$106,134</td>
<td>$115,969</td>
<td>$116,462</td>
<td>$119,786</td>
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<tr>
<td><strong>Gas</strong></td>
<td></td>
<td>$27,350</td>
<td>$24,981</td>
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<tr>
<td><strong>Total</strong></td>
<td>$150,067</td>
<td>$133,483</td>
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<td>$140,827</td>
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<td><strong>Cost/SqFt</strong></td>
<td>$1.03</td>
<td>$0.92</td>
<td>$0.97</td>
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<tr>
<td><strong>Electric (MBtu)</strong></td>
<td>3,930.6</td>
<td>3,389.8</td>
<td>3,653.6</td>
<td>3,646.7</td>
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<tr>
<td><strong>Gas (MBtu)</strong></td>
<td>3,451.0</td>
<td>3,464.6</td>
<td>3,330.8</td>
<td>3,248.8</td>
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<tr>
<td><strong>Total (MBtu)</strong></td>
<td>7,381.5</td>
<td>7,036.5</td>
<td>6,984.4</td>
<td>6,895.5</td>
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<tr>
<td><strong>HVAC System Size</strong></td>
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<td></td>
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<tr>
<td>Heating (kBtu/h)</td>
<td>1,383.0</td>
<td>1,394.8</td>
<td>1,160.3</td>
<td>1,177.8</td>
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<tr>
<td>Cooling (Tons)</td>
<td>150</td>
<td>130</td>
<td>135</td>
<td>138</td>
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<tr>
<td><strong>EEM Economics</strong></td>
<td></td>
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<tr>
<td>EEM Savings</td>
<td>NA</td>
<td>$16,584</td>
<td>$9,117</td>
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<td>EEM Costs (see note 2)</td>
<td>NA</td>
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<td><strong>Payback</strong></td>
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<td>5.45</td>
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## Energy Modeling Parametric Runs – Combination Runs

### EEM Combination Design Runs

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<th>Budget Blg</th>
<th>ASHRAE</th>
<th>ASHRAE Plus EEMs</th>
<th>GSHP</th>
<th>GSHP Plus EEMs</th>
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<td>Cost/SqFt</td>
<td>$1.03</td>
<td>$0.80</td>
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### Estimated Operating Costs

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<th>GSHP Plus EEMs</th>
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<td>Electric (Electric)</td>
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<td>$90,764</td>
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<td>Gas (Gas)</td>
<td>$25,882</td>
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<td>Total (Total)</td>
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<td>$116,111</td>
<td>$72,547</td>
<td>$69,901</td>
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### Building Energy Use (Mbtus)

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<th>GSHP</th>
<th>GSHP Plus EEMs</th>
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<tbody>
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<td>Electric (MBtu)</td>
<td>3,930.6</td>
<td>2,884.2</td>
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<tr>
<td>Gas (MBtu)</td>
<td>3,451.0</td>
<td>3,379.5</td>
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<tr>
<td>Total (MBtu)</td>
<td>7,381.5</td>
<td>6,263.7</td>
<td>2,315.9</td>
<td>2,252.9</td>
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### HVAC System Size

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<th>GSHP</th>
<th>GSHP Plus EEMs</th>
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<tr>
<td>Heating (Btu/h)</td>
<td>1,383.0</td>
<td>911</td>
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<td>911</td>
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<tr>
<td>Cooling (Tons)</td>
<td>150</td>
<td>96</td>
<td>91</td>
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### EEM Economics

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<th>ASHRAE Plus EEMs</th>
<th>GSHP</th>
<th>GSHP Plus EEMs</th>
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<tbody>
<tr>
<td>EEM Savings/year 1</td>
<td>NA</td>
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<td>$77,520</td>
<td>$80,166</td>
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<tr>
<td>EEM Costs</td>
<td>NA</td>
<td>$34,450</td>
<td>$35,500</td>
<td>-$275,550</td>
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<td>Payback 1</td>
<td>NA</td>
<td>1.00</td>
<td>0.00</td>
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### EEM Combination Design Runs

**EEM Combination Design Runs**

- **Budget Blg**: $1.03
- **Cost/SqFt**: $0.80
- **Estimated Operating Costs**
  - **Electric**: $124,184
  - **Gas**: $25,882
  - **Total**: $150,067
- **Building Energy Use (Mbtus)**
  - **Electric (MBtu)**: 3,930.6
  - **Gas (MBtu)**: 3,451.0
  - **Total (MBtu)**: 7,381.5
- **HVAC System Size**
  - **Heating (Btu/h)**: 1,383.0
  - **Cooling (Tons)**: 150
- **EEM Economics**
  - **EEM Savings/year 1**: $36,912
  - **EEM Costs**: $124,450
  - **Payback 1**: 3.37 years

**GSHP EEMs w/ Daylighting**

- **Estimated Operating Costs**
  - **Electric**: $72,547
  - **Gas**: $0
  - **Total**: $72,547
- **Building Energy Use (Mbtus)**
  - **Electric (MBtu)**: 2,315.9
  - **Gas (MBtu)**: 0.0
  - **Total (MBtu)**: 2,315.9
- **HVAC System Size**
  - **Heating (Btu/h)**: 911
  - **Cooling (Tons)**: 91
- **EEM Economics**
  - **EEM Savings/year 1**: $80,166
  - **EEM Costs**: -$275,550
  - **Payback 1**: 0.00
Integrative Design Mantra

Everyone
Engaging
Everything
Early
A High Performance Liver?
Regenerative
Less Energy Required
More Energy Required
Restorative
Sustaining / Conservation
Conventional Practice
Technologies / Techniques
Fragmented Thinking
Living Systems Understanding
Whole System Pattern Thinking
Regenerating System
High Performance
Green
Conventional Practice
Trajectory of Environmentally Responsible Design

© All rights reserved. Regenesis 2006 - Contact Bill Reed, reed@integrativedesign.net for permission to use
What is Integrative Design? . . . revisited

Addresses interrelationships between: . . . the four key subsystems

Earth  Habitat

Wind  Water

Fire  Energy

Water  Materials

Outcome:
the health of the whole
What is Integrative Design? . . . revisited

A process for discovering the mutually beneficial interrelationships between:

- Habitat
- Water
- Energy
- Materials

. . . for the purpose of participating in the health of the place
An alternative Approach –
The ancients knew this . . .

Requires a Different Mind and Different Approach
“The Salvages are accustomed to set fire of the Country in all places where they come, and to burne it twize a year: at the Spring, and the fall of the leafe.”

-Thomas Morton
Feral landscapes . . . inhospitable to life

“The white man sure ruined this country, It’s turned back to wilderness”
(James Rust, a Southern Miwok elder) as quoted in *Tending the Wild*, M. Kat Anderson
Native Americans “believe that when humans are gone from an area long enough, they lose the practical knowledge about correct interaction, and the plants and animals retreat spiritually from the earth or hide from humans. When intimate interaction ceases, the continuity of knowledge passed down through generations, is broken, and the land becomes ‘wilderness’.”

Tending the Wild, M. Kat Anderson
What is Integrative Design?

Integrate:

to make into a whole by bringing all parts together; unify

Whole:

containing all components;
complete; not injured

Heal:

to make whole

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Are we wholing?
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A New Mind is needed

Working as a Whole

EXPERIENCE =

USABILITY/ANALYTIC + DESIGN/CREATIVE

Left-Brain Functions
Analytic thought
Logic
Language
Science and math

Right-Brain Functions
Holistic thought
Intuition
Creativity
Art and music
Systems and Whole Systems

Elements

Interconnections

Purpose

(We act on technical systems)
(Living Systems act themselves - mind, consciousness, role)
Two Types of Systems Thinking = a Whole

Technical Systems (relationships of pieces)

Living Systems (patterns and archetypes)
Living System ‘Process Tool’

Place
People
Pattern
Purpose
Potential

Evolving - Story of Place®
Place:

A sophisticated dynamic system

An organism - formed by energy flows and nutrient exchanges between all entities
Pattern

The quality of the whole

A model to be followed

Archetype: a model that sets a pattern
Story - Essence Symbol - Purpose
“Living Bridge”
Story -

Harmonizing People and Place

Who are these places?
Story - Essence Symbol
“Intelligent Membrane (Estuary)”
Story - Essence Symbol: “Membrane (Estuary)”
Vocation: regenerating the health of the Sea of Cortez”
Story - Essence Symbol: “Membrane (Estuary)”
Story - Essence Symbol:
“Membrane (Estuary)”
Story - Essence Symbol:
“Membrane (Estuary)”
Potential - Building Capacity for Co-Evolution

Keeping “caring” alive

Ecological literacy

Spirit of the Living System, Consciousness

Speaks to our role – if our role is passive then we end up as we are – or less.
Willow School:

... A more compelling and vital story of place
“If you save the living environment it automatically will save the physical environment. If you just save the physical environment (as we’ve come to understand it), we’ll lose both.”

E.O. Wilson (Wilson’s Law)
Our Role?

Inhabit the earth – don’t occupy it.

- From living lightly on - to living fully with - the land
- Invite ‘place’ to inhabit us.

Re-purpose our role as architects and humans

- Humans can circumlocate, recognize, and re-pattern

Engage design as a developmental process
Re-membering

Image from www.wri.org
Information

www.sevengroup.com

www.regenesis.com

www.integrativedesign.net